This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claims 1-9 (Canceled)

Claim 10 (Previously presented): The apparatus of claim 31, wherein the reflector layer has a thickness in the range of about 3 to about 30 nanometers.

Claim 11 (Canceled)

Claim 12 (Previously presented): The apparatus of claim 28, wherein the light source is a laser configured for emitting the transmitted light as collimated light.

Claim 13 (Previously presented): The apparatus of claim 12, wherein the transmitted light has a wavelength of about 850 nanometers and an intensity selected from the range of about 1 to about 3 microWatts.

Claim 14 (Withdrawn): An apparatus for use in measuring diffusible hydrogen concentrations in a selectable portion of a structure, comprising:

a housing having a first opening adapted for being operatively and selectively connected to a selected portion of the structure, whereby hydrogen evolving from the selected portion is captured within the housing; and

a hydrogen sensor mounted in the housing so as to be exposed to the captured evolving hydrogen from the selected portion, wherein the hydrogen sensor comprises material that changes optical properties based on concentration of the captured evolving hydrogen.

Claim 15 (Withdrawn): The apparatus of claim 14, wherein the housing defines a sample area on the selected portion of the structure and defines a sample volume adjacent the hydrogen sensor wherein the captured evolving hydrogen is sealably contained, and wherein the diffusible hydrogen concentrations of the selected portion of the structure are measurable based on the sample area, the sample volume, and the changes in the optical properties of the hydrogen sensor.

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Claim 16 (Withdrawn): The apparatus of claim 15, further including an optical fiber for directing light to and away from the hydrogen sensor, the optical fiber being mounted within the housing with a first end adjacent the hydrogen sensor and a second end proximal to a second opening of the housing.

Claim 17 (Withdrawn): The apparatus of claim 16, further including a reflector mounted in the housing adjacent the first opening and interposed between the hydrogen sensor and the sample volume, wherein the reflector comprises a material that adsorbs and releases molecular hydrogen and that reflects light.

Claim 18 (Withdrawn): The apparatus of claim 17, further including a hydrogen monitoring assembly operably connected to the second end of the optical fiber and adapted for transmitting light to the second end of the optical fiber, for receiving a portion of the transmitted light that passes through the hydrogen sensor and is reflected by the reflector, and for determining a diffusible hydrogen concentration of the selected portion of the structure based on the received portion of the transmitted light.

Claim 19 (Currently amended): A method for measuring a diffusible hydrogen concentration in an object, comprising:

selecting a portion of the object from which to obtain a diffusible hydrogen concentration measurement;

sealably mounting a hydrogen sensor assembly on the selected portion of the object, the sensor assembly including a housing that defines a sample area on the selected portion from which hydrogen is allowed to evolve and a predetermined sample volume in which the evolving hydrogen is captured, wherein the sensor assembly further includes a hydrogen sensor comprising a hydrogen-reactive, chemochromatic material mounted within the housing adjacent the sample volume;

allowing the hydrogen sensor to react with the captured evolving hydrogen for a sample time;

measuring change in a physical property of the hydrogen sensor over said sample time;

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correlating said change via a predetermined relationship between the physical property measured and concentration of hydrogen to obtain a rate of change of hydrogen in the sample volume during the sample period, which corresponds to hydrogen diffusivity rate from the object; and

determining the diffusible hydrogen concentration in the selected portion of the object based on the ~~measured amount~~ rate of change in the physical property of the hydrogen sensor by correlating the rate of change ~~of hydrogen~~ in the ~~sample volume~~ physical property via a predetermined relationship between rate of change ~~of hydrogen~~ in the ~~sample volume~~ physical property to diffusible hydrogen concentration in the object.

Claim 20 (Previously presented): The method of claim 19, wherein the sample time is in a range of 10 to 30 minutes.

Claim 21 (Currently amended): The method of claim 19, wherein the selected portion is a welded joint, and further including prior to the mounting, waiting a cooling time period after the welded joint is welded, and determining an initial diffusible hydrogen concentration in the ~~selected portion by multiplying the hydrogen diffusivity rate times by the time since the initial weld process was completed~~ welded joint by correlating the hydrogen diffusivity rate at the cooling time with a predetermined example slope from among a plurality of pre-determined example slopes of hydrogen diffusion curves for a plurality of example initial diffusible hydrogen concentrations at said cooling time period.

Claim 22 (Original): The method of claim 19, wherein the physical property is optical transmissivity of the hydrogen sensor and the sensor assembly further includes a reflector positioned within the housing so as to be interposed between the sample volume and the hydrogen sensor, the reflector being configured for reflecting light passing through the hydrogen sensor back through the hydrogen sensor.

Claim 23 (Original): The method of claim 22, further including operatively connecting a reflectance monitoring device including a light source and a light signal detector to the sensor assembly, and wherein the measuring includes operating the reflectance monitoring

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device to transmit a light signal from the light source to the hydrogen sensor and to receive a reflected portion of the light signal with the light signal detector.

Claim 24 (Original): The method of claim 23, further including connecting a signal analyzer to the light signal detector for receiving a signal from the light signal detector based on the received reflected portion, and wherein the calculating of the diffusible hydrogen concentration is completed in part by operating the signal analyzer to compare the signal from the light signal detector and the transmitted light signal from the light source.

Claim 25 (Original): The method of claim 19, further including calibrating the hydrogen sensor assembly to create calibrating information, and wherein the calculating of the diffusible hydrogen concentration is based on the calibrating information.

Claim 26 (Original): The method of claim 26, the calibrating being completed prior to the mounting of the hydrogen sensor assembly based on measurements of the sample area and the sample volume and based on collected calibration testing information.

Claim 27 (Original): The method of claim 26, the calibrating being completed after the mounting of the hydrogen sensor on the object and including injecting a selected amount of hydrogen into the sample volume, allowing the selected amount of hydrogen to react with the hydrogen sensor for a predetermined calibration time, and measuring the amount of change in the physical property of the hydrogen sensor.

Claim 28 (Currently amended): Diffusible hydrogen sensor apparatus for detecting hydrogen diffusing from a solid metal object, comprising:

a sensor housing with a sealing member attached thereto disposed to surround a leak proof predetermined sample area of an object to be measured;

the sensor housing having a predetermined sample volume within the housing adjacent to the sample area to define a leak proof sample chamber enclosing the object to be measured;

a hydrogen sensor mounted in the sensor housing with a sealed connection to the leak proof sample chamber;

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the hydrogen sensor further comprising a layer of hydrogen-reactive chemochromic material in communication with the leak proof sample chamber;

a light source optically connected to the sensor housing to transmit light to the hydrogen sensor wherein the properties of light reflected from the layer of hydrogen-reactive chemochromic material varies as a function of hydrogen concentration in the leak proof sample chamber; and

a detector and signal analyzer connected to the sensor housing for receiving the reflected light from the layer of hydrogen-reactive chemochromic material wherein the reflected light is detected and analyzed by the signal analyzer to correlate the variations in the light input to ~~a quantity~~ quantities of hydrogen in the predetermined sample volume and to then correlate an increase in such ~~a calculated quantity~~ quantities of hydrogen in the sample volume to a diffusivity rate of the hydrogen diffusing from the solid metal object, and for further correlation of the diffusivity rate to a diffusible hydrogen concentration in the ~~leak proof predetermined sample area of the object to be measured wherein the physical properties of the chamber are used to calculate the quantity of hydrogen present~~ solid metal object by correlation of the diffusivity rate to a plurality of example slopes of hydrogen diffusion curves for a plurality of example diffusion hydrogen concentrations that are predetermined for example solid metal objects.

Claim 29 (Previously presented): The apparatus of claim 28 wherein the chemochromic material being selected from a group consisting of transition metal oxide, tungsten trioxide, molybdenum trioxide, yttrium dihydride, rare earth dihydride, or lanthanum dihydride,

Claim 30 (Previously presented): The apparatus of claim 29, wherein a reflective layer of catalytic material is added to the chemochromic material that adsorbs molecular hydrogen, converts the molecular hydrogen to atomic hydrogen, and release the atomic hydrogen into the hydrogen reactive chemochromic layer.

Claim 31 (Previously presented): The apparatus of claim 30 wherein the reflective layer of catalytic material is selected from a group consisting of palladium or platinum.

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Claim 32 (Previously presented): The apparatus of claim 13, wherein the light source produces light anywhere in a bandwidth range from white light to single wavelength infrared.

Claim 33 (Previously presented): A method for measuring a diffusible hydrogen concentration in an object comprised of a type of material, comprising:

selecting a portion of the object from which to obtain a diffusible hydrogen concentration measurement;

sealably mounting a hydrogen sensor assembly on the selected portion of the object, the sensor assembly including a leak proof sample chamber that defines a sample area on the selected portion from which hydrogen is allowed to evolve into a predetermined sample volume in which the evolving hydrogen is captured, wherein the sensor assembly further includes a hydrogen sensor comprising a hydrogen-reactive, chemochromatic material mounted within the housing adjacent the sample in communication with the leak proof sample chamber;

transmitting a light input to the hydrogen sensor wherein the properties of light after being transmitted through the layer of hydrogen-reactive chemochromic material varies as a function of hydrogen concentration in the leak proof sample chamber;

detecting the light after it is transmitted through the layer of hydrogen-reactive chemochromic material for a sampling time period;

analyzing the detected light to correlate change in the detected light during the sampling time period to a rate of change in volume of hydrogen in the predetermined sample volume based on a predetermined calibration that correlates changes in the light detected to rates of change in volume of hydrogen for the predetermined sample volume; and

correlating the rate of change in the volume of hydrogen to a diffusible hydrogen concentration in the sample area of the object based on a predetermined relationship between rates of change in the volume of hydrogen to diffusible hydrogen concentration in said type of material.

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Claim 34 (Previously presented) The method of claim 33 whereby the chemochromic material being selected from a group consisting of transition metal oxide, tungsten trioxide, molybdenum trioxide, yttrium dihydride, rare earth dihydride, or lanthanum dihydride,

Claim 35 (Previously presented) The method of claim 34 whereby reflective layer of catalytic material is added to the chemochromic material that adsorbs molecular hydrogen, converts the molecular hydrogen to atomic hydrogen, and release the atomic hydrogen into the hydrogen reactive chemochromic layer.

Claim 36 (Previously presented): The method of claim 35 whereby the reflective layer of catalytic material is selected from a group consisting of palladium or platinum.

Claim 37 (Previously presented): The method of claim 33 whereby the light input produces light anywhere in a bandwidth range from white light to single wavelength infrared.

Claim 38 (Previously presented): The method of claim 19, wherein the predetermined relationship between the changes in detected light and rates of change in volume of hydrogen is predetermined empirically by measuring the light after it is transmitted through the layer of hydrogen-reactive chemochromic material for each of a plurality of samples with known hydrogen concentrations to establish a curve that quantifies the measured light versus hydrogen concentration, calculating the volumes of hydrogen in the predetermined sample volume for a plurality of hydrogen concentrations, correlating the measurements of light for the plurality of samples with known hydrogen concentrations to the volumes of hydrogen in the predetermined sample volume for the plurality of hydrogen concentrations to create a direct relationship between the measurements of light and volumes of hydrogen and between rates of change of the light to rates of change of hydrogen volume.

Claim 39 (Previously presented): The method of claim 19, wherein the predetermined relationship between rate of change of hydrogen volume to diffusible hydrogen concentration in said type of material is predetermined empirically by determining rate of change of hydrogen volume for each of a plurality of samples of said type of material having known diffusible hydrogen concentrations to establish a curve that quantifies rates of change of hydrogen volume versus diffusible hydrogen concentrations in objects.

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Claim 40 (New)   A method of subsequent determination of an initial volume of hydrogen per unit mass of metal that was present in a particular welded metal joint specimen when the particular welded metal joint specimen was welded, comprising:

creating a set of example curves with slopes that are representative of respective diffusivity rates of hydrogen evolving from example welded metal joints as a function of time after welding for a plurality of respective example values of initial volumes of hydrogen per unit mass of metal in the example welded metal joints;

determining an actual diffusivity rate of hydrogen evolving from the particular welded metal joint in a particular time period after welding; and

determining the initial volume of hydrogen per unit mass of metal that was present in the particular welded metal joint specimen when the particular welded metal joint specimen was welded by correlating the actual diffusivity rate in the particular time period after welding with the slopes of the example curves for the same time period.

Claim 41 (New)   The method of claim 40, including determining the actual diffusivity rate of hydrogen evolving from the particular welded metal joint specimen by positioning and sealing a sample chamber with a sample opening on the particular welded metal joint specimen so that hydrogen evolving from the particular welded metal joint specimen is captured in the chamber, and measuring in the time period a change of a parameter that is correlated to diffusivity rate of the hydrogen that evolves from the particular welded metal joint into the sample chamber.

Claim 42 (New)   The method of claim 41, wherein the parameter is intensity of light that varies as a function of hydrogen concentration in the sample chamber.

Claim 43 (New)   The method of claim 42, wherein the change of intensity of light is correlated to the diffusivity rate of the hydrogen that evolves from the particular welded metal joint specimen into the sample chamber by calibrating the intensity of light parameter to specific concentrations of hydrogen, multiplying the concentrations of hydrogen by the

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volume of the sample chamber to correlate the light intensity parameter to volume of hydrogen in the sample chamber, and dividing changes in the volume of hydrogen in the sample chamber by the time in which such changes in the volume of hydrogen in the sample chamber occur to correlate the measured changes of intensity of light parameter to actual diffusivity rates of hydrogen evolving from the particular welded metal joint specimen into the sample chamber.

Claim 44 (New)   The method of claim 43, including positioning a chemochromic material in the sample chamber, said chemochromic material having a characteristic light transmissivity that varies in response to exposure to hydrogen, directing a light beam to pass through the chemochromic material at least once, and measuring the parameter as loss of intensity of the beam of light upon passing through the chemochromic material.

Claim 45 (New)   The method of claim 41, wherein the parameter is a property of an electric circuit that varies as a function of hydrogen concentration in the sample chamber.

Claim 46 (New)   The method of claim 45, wherein the parameter is electric current that varies as a function of hydrogen concentration in the sample chamber.

Claim 47 (New)   The method of claim 46, including positioning a material in the sample chamber that varies in electrical resistivity in response to exposure to hydrogen, applying a voltage across the material, and measuring the electric current that flows through the material.

Claim 48 (New)   The method of claim 40, including creating the set of example curves by welding a sample welded metal joint, determining the diffusivity rate of hydrogen evolving from the sample welded metal joint by measuring the parameter in a sample time period after the sample is welded and plotting the measurements of the parameter as a function of time to obtain an actual response slope that represents the diffusivity rate,

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deriving an equation that closely correlates in shape and slope to the plot of the measurements of the parameter as a function of time, and developing the set of example curves from the equation for a plurality of different initial diffusion hydrogen concentrations as a function of time.

Claim 49 (New)   The method of claim 48, including deriving the equation from an error function.

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